PATENT SPECIFICATION (11) 1 225 054

DRAWINGS ATTACHED

1 225 054

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(31) Convention Application No.
P 16 38 108.1 (32) Filed 10 Feb. 1968 in
(33) Germany (DT)
(45) Complete Specification published 17 March 1971
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H3B 9S

(54) LIMIT SWITCH

(71) We, ROLF KREEB of 38 Buchelweg, Ravensburg, Germany and ALBERT OSTERTAG of 17 Erlenweg, Ravensburg,

PATENTS RULES 1968

SPECIFICATION NO. 1,225,054

The following amendments were made under Rule 152 on 2 September 1971:-

Page 1 *delete* lines '1 to 4' *insert* '(71) We,'

Page 1, line 5 *delete* 'together as'

Page 1, line 6 *after* 'Spezialfabrik' *insert* 'a German Kommanditgesellschaft'

THE PATENT OFFICE
24 September 1971

R 5599/31

control impulses.

As is known, contactless switches of this kind have particularly advantageous properties by comparison with those having mechanical contacts, these advantages consisting, in particular, of chatter-free contact making, constant transitional resistance over a long duration, insensitivity to moisture and vibration, high switching frequency and only moderate force required for their operation.

These properties are particularly important in limit switches, and the following additional requirements arise: reproducing of a switching position, high switching accuracy, switching speed independent of the speed of operation of the control means of the switch.

According to the present invention there is provided a contact-less limit switch comprising one or more magnets, a magnetoresistive element and a control means, wherein the resistance of the magnetoresistive element is variable within pre-determined limits by variations of the magnetic field produced by said magnet or magnets and coupled to said magnetoresistive element, the variation of the magnetic field and

[*Price 25p*]

grams having been allocated the same reference number throughout.

In this system a switch housing of plastics is marked 1, a operating push rod 2, a magnetoresistive element 3 and the space for accommodating a electronic amplifier system 4.

Fig. 1 shows a contactless limit switch in which a permanent magnet 5 with pole pieces 6 and the magnetoresistive elements 3 are permanently installed in the housing 1. The operating push rod 2 is fitted with a short circuit magnetic plate 7 which can be moved in the direction of the pole pieces 6, in opposition to a spring 8.

Method of operation

When the switch is in the inoperative position shown, magnetic lines of force of a certain density pass through the magnetoresistive element 3, as a result of which a certain resistance value is established in the latter. In order to generate a switching impulse the short circuit plate 7 is moved in

SPECIFICATION AMENDED - SEE ATTACHED SLIP

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(54) LIMIT SWITCH

(71) We, ROLF KREEB of 38 Buchelweg, Ravensburg, Germany and ALBERT OSTERTAG of 17 Erlenweg, Ravensburg, Germany, both German Nationals, trading together as RAFI RAIMUND FINSTERHÖLZEL ELEKTROTECHNISCHE SPEZIALFABRIK of 20 Allmandstrasse, Ravensburg, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to the construction of limit switches for use in establishing switching processes, being provided with one or more magnetic resistive elements through which current passes, as well as one or more magnets, said element or elements and magnet or magnets being arranged so as to be movable in relation to one another, in order to generate electrical control impulses.

As is known, contactless switches of this kind have particularly advantageous properties by comparison with those having mechanical contacts, these advantages consisting, in particular, of chatter-free contact making, constant transitional resistance over a long duration, insensitivity to moisture and vibration, high switching frequency and only moderate force required for their operation.

These properties are particularly important in limit switches, and the following additional requirements arise: reproducing of a switching position, high switching accuracy, switching speed independent of the speed of operation of the control means of the switch.

According to the present invention there is provided a contact-less limit switch comprising one or more magnets, a magnetoresistive element and a control means, wherein the resistance of the magnetoresistive element is variable within pre-determined limits by variations of the magnetic field produced by said magnet or magnets and coupled to said magnetoresistive element, the variation of the magnetic field and hence the change of resistance of said element being produced by movement of said control means, which change of resistance is utilized to generate a switching impulse.

This principle enables the aforementioned conditions to be fulfilled, different versions of the contactless limit switch basically according to the invention being provided for, in accordance with the particular special constructional and functional conditions prevailing.

These fundamental examples for the practical application of the principle of the invention are described below in conjunction with the drawings, each of the individual figures 1-6 providing a schematic diagram of a switch in longitudinal section, a given component occurring in different diagrams having been allocated the same reference number throughout.

In this system a switch housing of plastics is marked 1, a operating push rod 2, a magnetoresistive element 3 and the space for accommodating a electronic amplifier system 4.

Fig. 1 shows a contactless limit switch in which a permanent magnet 5 with pole pieces 6 and the magnetoresistive elements 3 are permanently installed in the housing 1. The operating push rod 2 is fitted with a short circuit magnetic plate 7 which can be moved in the direction of the pole pieces 6, in opposition to a spring 8.

Method of operation

When the switch is in the inoperative position shown, magnetic lines of force of a certain density pass through the magnetoresistive element 3, as a result of which a certain resistance value is established in the latter. In order to generate a switching impulse the short circuit plate 7 is moved in

the direction of the pole pieces 6 by the push rod 2. The magnetic field is thus transferred to the short circuit plate 7, a maximum being obtained when the pole pieces are in contact with the short circuit plate. Under these conditions the magnetoresistive element has the lowest resistance.

This change in the resistance can be utilized in a known manner, via a suitable electronic system accommodated in the chamber 4, in order to generate a switching impulse. In this system a switching position which is reproducable can be established, so that a high degree of accuracy is obtained.

Fig. 2 shows a contactless limit switch in which the operating push rod 2, displaceably mounted in the housing 1, carries a magnet 10 with the pole pieces 11. Opposite to these latter a biasing magnet 12 is permanently mounted in the housing, its pole pieces being constructed as intercepting plates 13 between which the magnetoresistive element 3 is intercalated.

Method of operation

When the operating push rod 2 is pushed in, the magnet 10 is moved in the direction of the biasing magnet 12. The intercepting plates 13 of the latter collect the magnetic field lines emanating from the pole pieces 11 and guides them through the magnetoresistive element 3, as a result of which the resistance of this latter is increased. As the like poles of the magnets 10 and 12 are opposite each other, the restoring force is obtained from the field lines, so that no spring is necessary.

In this version the electrical function can be reversed by reversing the poles of one of the two magnets. In this case the fields of force of the two magnets cancel each other out, when they are moved towards each other and the resistance in the magnetoresistive element becomes less.

The switching accuracy can in this case be increased by the installation of two or more magnet systems with magnetoresistive elements, in conjunction with electronic comparison circuits.

Fig. 3 shows a contactless switch in which a biasing magnet 15 with the pole pieces 16 and the magnetoresistive element 3 is rigidly built into the housing 1. Here again, the pole pieces are fitted with intercepting plates 17, which are mounted on an external end face of the housing.

Method of operation

In this version the alteration to the resistance in the magnetoresistive element 3 is obtained as a result of the fact that a magnet 18, outside the housing, is moved past in the direction of the arrow P. Owing to the intercepting plate 17 the magnet field then becomes denser in the zone of the magnetoresistive element 3 and increases the resistance of the latter. As no mechanical wear can be suffered in this case, this limit switch will last for a practically unlimited length of time.

If the poles of one of the magnets 15 and 18 are reversed this results, as described in connection with Fig. 2, in a reversed electrical effect. In this case the magnet 18, when the switching operation is performed, is moved in the direction shown by the arrow P'.

In the present version the magnet 18 can be replaced by a short circuit plate, in which case the function of the arrangement shown in Fig. 1 would be obtained.

Fig. 4 shows a contactless limit switch with quick-break action. In this case a magnet 20 with the pole piece 21 is permanently installed in the housing 1. Opposite the pole piece is a magnetoresistive element support 22 for the magnetoresistive element 3, in addition to which a stop 23 is provided for a rocker 24. This rests on a blade 25 of the pole piece 21 and is provided with a stop 26.

The push rod 2 which operates the rocker is mounted in a guide bushing 27 and acts via a follow-up spring 28 on a pressure pin 29, which rests on the rocker 24.

Method of operation

In the position of rest illustrated, the rocker 24 is held firmly against the stop 23 by the magnet 20 in which process the other arm of the rocker rests against the pressure pin 29. If the operating push rod 2 is moved in the direction of the rocker, in order to set up a switching impulse, then first of all the spring 28 is subjected to compression, this being the case until the elastic force overcomes the holding force of the magnet, whereupon the rocker suddenly moves away from the stop 23 altering its position in respect of the magnetoresistive element.

As the magnet field flows through the rocker 24 the movement of the latter leads to a sudden change of resistance in the magnetoresistive element 3, which change can be very advantageously utilized for actuating electronic circuits.

A special advantage of this version resides in the fact that even in the event of the slow operation of the push rod reliable switching characteristics are ensured, since the switching position is accurately adhered to. By selecting suitable dimensions, moreover, any desired operating relationship can be obtained between the movement of the push rod and the rocker.

The chamber 4 contains the electronic system marked 30, mounted in a printed circuit 31, which is connected direct to the magnetoresistive element.

Fig. 5 shows a contactless limit switch in

which a magnet 32, connected with the operating push rod 2 and having a pole pieces 33, is displaceably mounted in the housing and held in the inoperative position by the spring 34. The pole pieces 33 are brought together except for a small air gap 35, as a result of which a high concentration of the magnetic flux is obtained at this point.

Method of operation

When the push rod 2 is operated, or when the magnet 32 is moved towards the magnetoresistive element 3, this latter enters the airgap 35, resulting in a change in the resistance in the magnetoresistive element. Owing to the high magnetic field density in the air gap the resistance difference obtainable in the magnetoresistive element is likewise considerable, with a favourable effect on the production of the switching impulse and the switching accuracy.

Fig. 6 shows a contactless limit switch of which the switching point is adjustable. For this purpose one or more magnets 37 and 38 are mounted on a rotatable disc 39, which is mounted in the housing 1 and can be adjusted from the outside. The pole pieces of the magnets 37 and 38 are in this case likewise provided with an air gap 40. The magnetoresistive element 3 rests on a shaft 41 which is concentric with the rotatable disc and which can be rotated by the push rod 2, e.g. via a toothed segment 42 via the toggle lever 43 and a pressure pin 44, in which process the switching movement of the push rod takes place in opposition to a restoring spring 45, which, in the restoring movement to the inoperative position illustrated, subjects a further restoring spring 46 to tension. This latter can at the same time be utilized as a connecting conductor between the magnetoresistive element and the electronic system.

Method of operation

When the push rod 2 is pushed in, the movement is transferred to the disc 39, by the pressure pin 44, the toggle lever 43 and the toothed segment 42. In this process the magnetoresistive element enters the airgap 40 of the magnet 38 and alters its resistance, thus producing a switching impulse. The switching impulse is obtained by movement of the push rod 2, which causes the rotatable disc 39 to rotate, a system which, in the case of the limit switch, may be of advantage.

The construction of the switch in accordance with Fig. 6 also enables it to be used as a critical-value high transmitter between + and − tolerances, in which case, according to the particular deflection performed by the scanning device 2, the magnetoresistive element enters one or other of the magnets 37 and 38 and generates impulses which can be used, for example, for sorting purposes, when the surfaces of workpieces are being tested.

WHAT WE CLAIM IS:—

1. A contactless limit switch comprising one or more magnets, a magnetoresistive element and a control means, wherein the resistance of the magnetoresistive element is variable within pre-determined limits by variation of the magnetic field produced by said magnet or magnets and coupled to said magnetoresistive elements, the variation of the magnetic field and hence the change of resistance of said element being produced by movement of said control means, which change of resistance is utilized to generate a switching impulse.

2. A limit switch as claimed in claim 1, wherein a magnet is contained in a housing and provided with pole pieces between which the magnetoresistive element is rigidly mounted and of which the magnetic flux density between the pole pieces can be varied by a magnetic short circuit plate movable by the control means in the direction of the pole pieces and in opposition to the force of a spring.

3. A limit switch as claimed in claim 1, wherein a biassing magnet fitted with intercepting magnetic plates in which the magnetoresistive element is intercalcated is rigidly mounted in the housing, a magnet movable by means of the control means being mounted opposite the aforementioned biassing magnet in such a way that the like poles of the magnets are positioned opposite each other.

4. A limit switch as claimed in claim 1, wherein pole pieces of a single magnet bear a switching rocker which is movable in the magnetic field of said magnet in relation to the magnet-resistive element, said switching rocker being held in the inoperative position by the magnet, the control means being supported on the rocker, via a follow-up spring which is designed in such a way that the rocker on moving said control means is moved away from the magnet by the force of the spring.

5. A limit switch as claimed in claim 1, wherein a magnet with pole pieces is mounted in a housing in such a way as to be movable by means of the control means and in opposition to the force of a spring, a corresponding part of each pole piece projecting inwardly so that a small air-gap is left between the pole pieces which the magnetoresistive element enters when the control means is moved

6. A limit switch as claimed in claim 1, wherein two magnets each having an air-gap are affixed to a rotatable disc which is adjustable from the outside of the housing and wherein the magnetoresistive element is

mounted on a shaft concentric with the rotating disc and can be caused to enter the air-gap of one of the magnets by moving the control means, wherein a mechanical coupling means is provided for transmission of the operating movement of the control means to the magnetoresistive element.

7. A limit switch as claimed in any one of claims 1 to 6 wherein the said control means is a push rod, displaceable within a housing.

8. A limit switch as claimed in claim 1, wherein a magnet is provided with pole pieces between which the magnetoresistive element is fitted and the said magnet is fitted with intercepting magnetic plates and is rigidly mounted in a housing, and the control means comprises a tranversally or longitudinally movable magnet.

9. A limit switch as claimed in claim 1 or 8, wherein the said control means is a movable element positioned outside the housing.

10. A limit switch as claimed in claim 1 substantially as described with reference to the accompanying drawing.

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1,225,054 COMPLETE SPECIFICATION
1 SHEET

Fig. 1

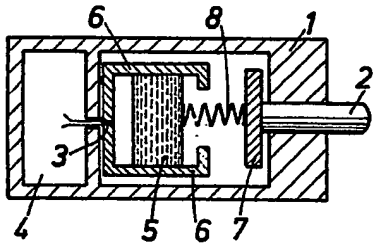
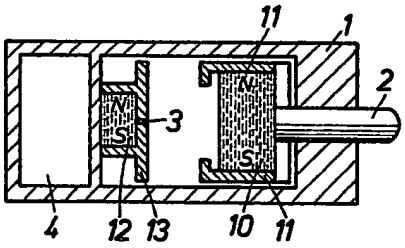


Fig. 2



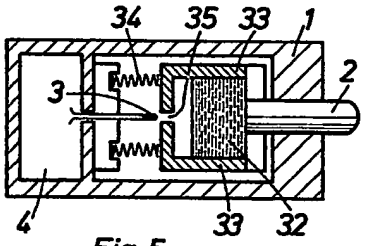


Fig. 5

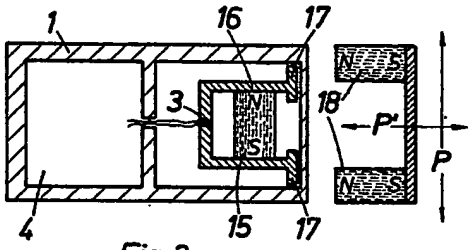


Fig. 3

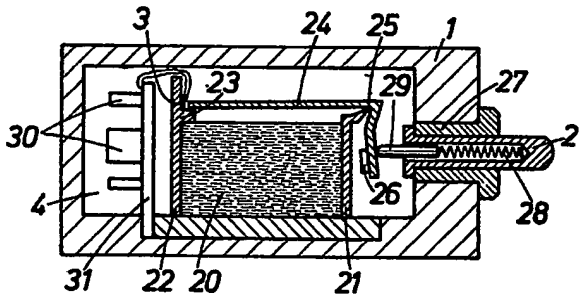


Fig. 4

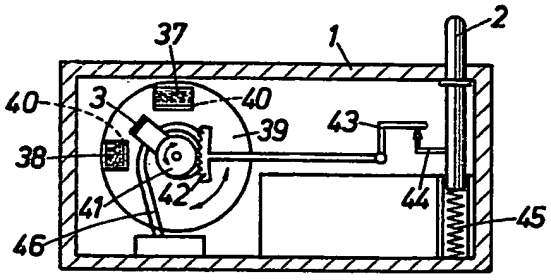


Fig. 6